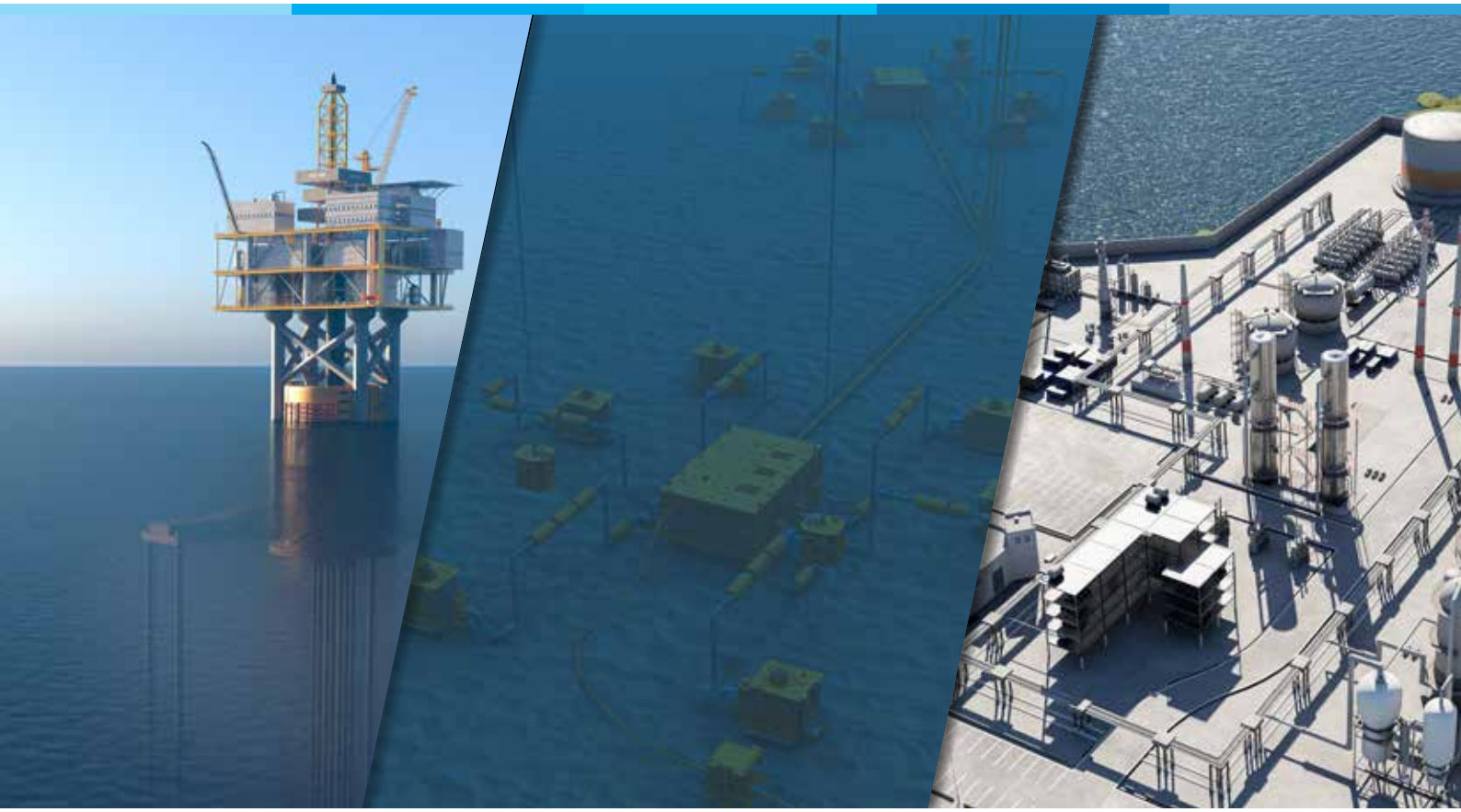
NORD-LOCK GROUP

ADVANCED TENSIONING FOR OIL & GAS OPERATIONS

ENGINEERED FOR EXTREME CONDITIONS — ENSURING PROVEN, RELIABLE PERFORMANCE FROM UPSTREAM TO DOWNSTREAM



SUPERBOLT® BOLTIGHT®

INTRODUCTION

According to Mordor Intelligence, the global oil and gas infrastructure market is projected to reach 494.91 billion USD by 2030, with North America remaining the largest regional market and Asia Pacific emerging as the fastest growing. Growth is also expected to remain strong in the Middle East, where Saudi Aramco has awarded over 25 billion USD in strategic gas expansion contracts, targeting a 60% increase in sales gas production by 2030 through the Jafurah field development and Master Gas System expansion. Meanwhile, the International Energy Forum forecasts global annual upstream investment to reach 738 billion USD within the same timeframe.

At the same time, the global energy landscape is shifting toward a low-carbon future. Carbon neutrality targets are accelerating innovation across the energy sector, with Nordic countries often cited as leaders in advancing low-carbon policies and technologies. While oil and gas companies continue to expand and invest across upstream, midstream, and downstream infrastructure, they are also playing an increasingly active role in driving the energy transition through integration with renewables.

As the energy sector advances toward greater efficiency and sustainability, the integrity of every structure — from offshore platforms and subsea pipelines to processing facilities and renewable infrastructure — depends on a single fundamental element: **bolted joints**.

THE IMPORTANCE OF BOLTED JOINTS

Bolted connections are essential to the safety, reliability, and structural integrity of oil and gas infrastructure across upstream, midstream, and downstream operations.

Failure of a single joint can jeopardize high-value equipment, threaten personnel safety, and increase environmental risk. Therefore, achieving and maintaining the correct preload is critical to ensure bolted joints can withstand extreme pressures, temperatures, vibration, and corrosion.

As infrastructure complexity and operating demands increase, traditional tightening methods often struggle to deliver reliable preload. Consequently, ensuring long-term asset integrity requires advanced mechanical and hydraulic tensioning technologies capable of supporting secure bolted connections across the entire asset lifecycle.

WHY THE CORRECT PRELOAD IS IMPORTANT

Preload is the tensile force applied to a bolt or stud to create the clamping force that holds components together and resists the working load. The right preload prevents fatigue and joint failure by keeping stress stable under load.

If the preload is below the working load, the joint may experience loosening, vibration, or leakage. However, too much preload can also be harmful, leading to bolt breakage, stress corrosion cracking, or component damage. Achieving the correct preload maintains joint integrity, prevents downtime, and ensures long-term reliability.

Across upstream, midstream, and downstream operations, bolted joints are exposed to extreme vibration, pressure, and temperature. In these environments, correct preload is critical — it prevents leaks, shutdowns, and structural failures, ensuring safety, operational stability, and long-term performance in vital connections.

THE DISADVANTAGES OF TRADITIONAL BOLT TIGHTENING

The two most common bolt tightening methods in the oil and gas industry are torqueing and thermal stretching. But they have major drawbacks.

Torqueing

Bolts larger than one inch typically require pneumatic, hydraulic, or electric torque tools and heavy torque multipliers. These tools are costly, cumbersome, and difficult to control. Because torque is applied directly to the nut, friction between threads and at the nut-to-joint interface reduces preload accuracy.

Thermal Stretching

This method heats bolts to create axial elongation, but large bolts demand excessive thermal energy. Overheating can damage materials and pose safety hazards, making the process unsuitable for critical applications.

RELIABLE TENSIONING AT EVERY TURN

Nord-Lock Group's Superbolt® mechanical tensioners and Boltight® hydraulic tensioners eliminate the problems associated with traditional tightening methods, while ensuring accurate preload for secure and reliable bolted joints.

SUPERBOLT®

SIMPLE TOOLS, SUPER RESULTS

Superbolt mechanical tensioners use multiple jackbolts threaded through the nut body to divide high preload into manageable torque values. This technology ensures easy installation and high accuracy, offering both standard and customized solutions for diverse application requirements.

- Easier, safer, faster tightening of large fasteners — using only hand tools
- Single-person operation without heavy equipment or specialized skills
- No pinch points or lifting hazards, minimizing operator risk
- Even load distribution reduces gasket compression, leakage, and joint failure
- Full traceability on all multi-jackbolt tensioner assemblies

BOLTIGHT®

THE FAST TRACK TO ACCURATE TENSIONING

Boltight hydraulic tensioners combine speed and accuracy for your preload requirements, operating multiple tensioners simultaneously for fast, even tightening. Boltight offers both standard and fully customized solutions for the highest preload, the widest range of sizes, and the toughest environmental challenges.

- Significant labor savings — reduce maintenance time by days or even weeks
- Simultaneous tensioning improves efficiency and offers a more uniform tightening procedure
- Kitted solutions and rental options available for quick maintenance support
- High bolt-load accuracy, typically within ±5%
- Precise preload control, directly proportional to the applied pressure

UPSTREAM

UNLOCKING ENERGY IN THE MOST EXTREME ENVIRONMENTS

The upstream sector drives oil and gas exploration, drilling, and production — often in the most demanding situations — from deep-water offshore platforms to high-pressure onshore wells. In these harsh conditions, reliable, precise, and fast bolting is not only important but also essential to ensure uptime, protect workers, and keep operations running at peak performance.

Key operations:

- Oil and gas exploration
- Drilling and development
- Production
- Onshore/offshore field development

COMMON CHALLENGES IN UPSTREAM

Structures supporting upstream operations are under constant attack from the elements and corrosion. Additionally, the threats of bolt fatigue and relaxation caused by vibration are also major concerns for everyone involved in the oil and gas industry.

- High dynamic loads and vibration from rotating equipment
- Limited access in confined spaces
- Saltwater corrosion
- Fast turnaround time demanded during critical shutdowns
- Need for real-time tensioning feedback

Superbolt® mechanical tensioning solutions

- **Multi-Jackbolt Tensioners (MJTs)** deliver precise preload and enhanced safety by replacing existing bolts, enabling accurate installation and efficient maintenance in confined or limited-access areas to secure critical joints against diverse operational challenges in harsh environments.
- **Load-Sensing Tensioners (LSTs) and Load-Sensing Flexnuts (LSFs)** feature built-in sensors that enable remote preload monitoring and live data reading with precise, repeatable accuracy. These SMART solutions retrofit existing bolts, improving uptime and reducing labor, equipment, and maintenance verification costs.

Boltight® hydraulic tensioning solutions

- **T-Series Standard Bolt Tensioners** deliver precise, reliable tightening for oil and gas flanges and key bolted connections in demanding applications. Combining corrosion-resistant construction, joint alignment compensation, and sequential operation, they ensure fast, uniform compression and long-term performance under extreme operating conditions.
- **Typhoon+ Tensioners** are engineered for rigorous environments requiring safe, efficient, and repeatable bolt tensioning. Featuring automatic spring return and corrosion-resistant design, they offer long service life and reliability in offshore and confined-space applications.

DESIGNED TO YOUR SPECIFICATION

For many applications, a standard product can be modified quickly to meet special requirements without significant cost or lead time. When modifications are not feasible, we provide complete custom-engineered solutions designed and manufactured to fit any size, load requirement, or environment.

Our custom solutions help reduce downtime for faster maintenance, enhance safety by achieving correct preload without heavy tools, overcome space restrictions with compact designs, and ensure reliable performance in extreme conditions. We also can manufacture custom solutions from exotic materials and with advanced coatings, and we offer specialized testing and SMART products for preload monitoring. With ongoing investment in global technology centers and local service networks, Nord-Lock Group secures your operations worldwide.

UPSTREAM APPLICATION: HARSH ENVIRONMENTS

Offshore applications demand tensioners that can withstand high winds, heavy seas, and highly corrosive conditions

Superbolt offshore tensioners are multi-jackbolt tensioners (MJTs) engineered for precise and reliable performance in these demanding environments. They incorporate three key features:

- A washer captive to the nut body to prevent component loss
- Integral flats on the nut for easier installation and removal on damaged stud threads
- Enhanced corrosion protection for marine exposure

Special coating options are available for bolted connections exposed to high humidity, chemicals, or saltwater, including:

- Xylan – Our strongest coating, providing exceptional corrosion and wear resistance
- Deltaprotekt – A zinc and aluminum flake-based coating that offers advanced corrosion protection

When your offshore application requires the toughest tensioners to stand up to harsh, corrosive conditions, choose Superbolt MJTs.

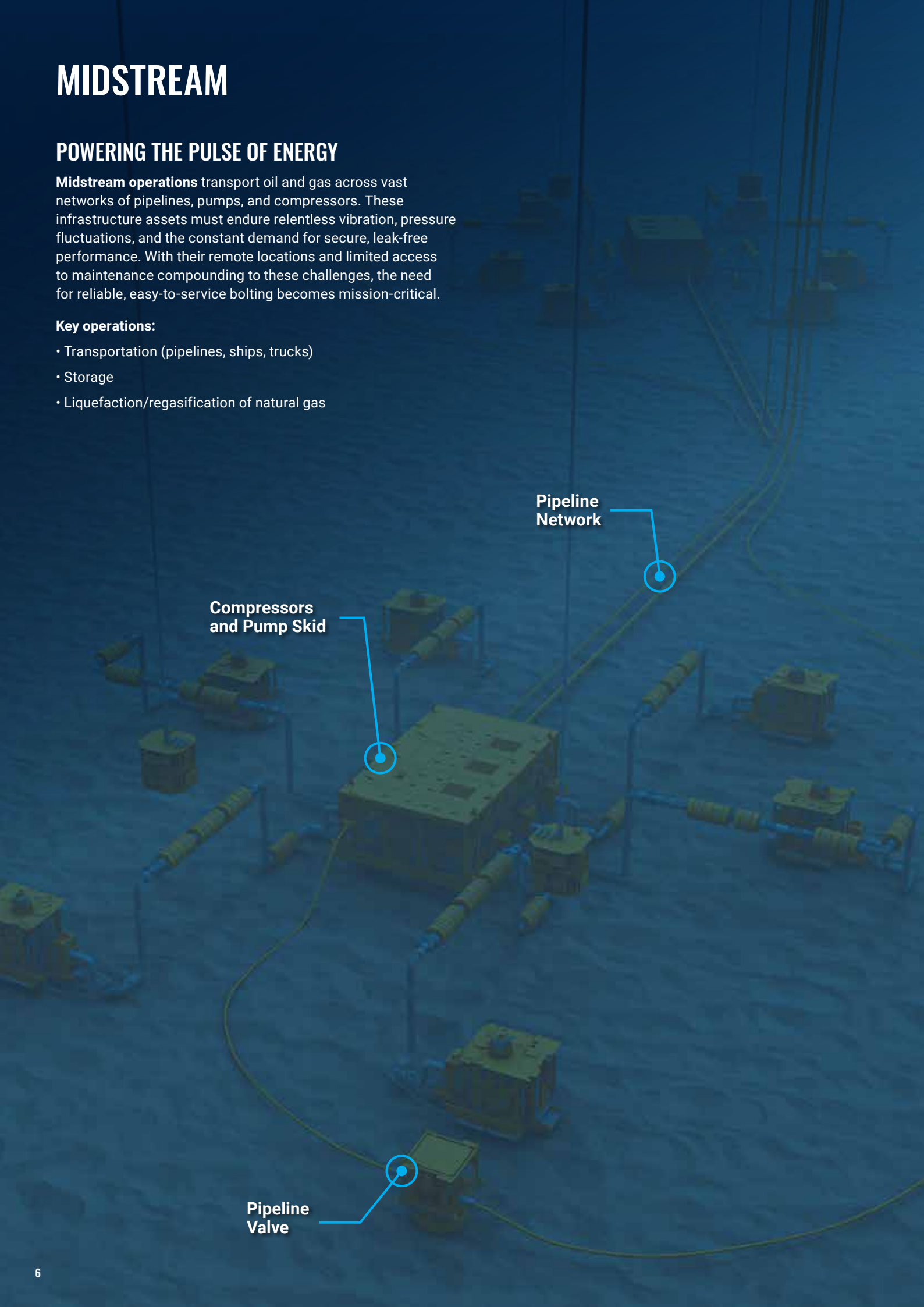
MIDSTREAM

POWERING THE PULSE OF ENERGY

Midstream operations transport oil and gas across vast networks of pipelines, pumps, and compressors. These infrastructure assets must endure relentless vibration, pressure fluctuations, and the constant demand for secure, leak-free performance. With their remote locations and limited access to maintenance compounding to these challenges, the need for reliable, easy-to-service bolting becomes mission-critical.

Key operations:

- Transportation (pipelines, ships, trucks)
- Storage
- Liquefaction/regasification of natural gas



COMMON CHALLENGES IN MIDSTREAM

Midstream operations involve the complicated logistics of moving oil and gas across oceans, deserts, and mountain ranges. It is critical that the infrastructure used in the transport, handling, and storage of these resources be up to several challenges.

- Pressure surges and vibration fatigue
- Leak prevention in remote, unmanned locations
- Long maintenance intervals and regulatory compliance
- Foundation bolt integrity and flange alignment

Superbolt® mechanical tensioning solutions

- **Multi-Jackbolt Tensioners (MJTs)** ensure accurate preload and long-term joint integrity in midstream operations, preventing leaks, reducing maintenance frequency and delivering safe, reliable performance across pipelines, flanges, and compressor stations under varying environmental conditions.
- **Flexnuts** add elasticity to the reactive side of the joint by flexing outward at the bottom and inward at the top of the nut, distributing bolt load evenly across threads, reducing stress concentrations, and ensuring durable, stable connections in demanding midstream applications.

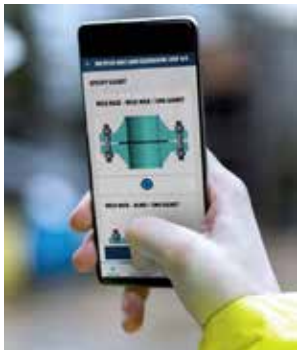
Boltight® hydraulic tensioning solutions

- **Subsea Tensioners** feature a nickel-plated, corrosion-resistant design engineered for demanding subsea applications, ensuring safe, efficient installation and long-term reliability in underwater oil and gas operations.
- **Multi-Stud Tensioners (MSTs)** tighten multiple bolts simultaneously, reducing installation time and ensuring uniform preload in subsea flanges, manway covers, vessel lids, and other high-integrity bolted connections.
- **Engine Tool Sets** deliver precise hydraulic tensioning for gas and diesel engines. Available in standard OEM sets or fully customized designs to match specific installation and maintenance needs.

SUPPORT AND SERVICES

Before you buy a mechanical or hydraulic bolt tensioner for your standard flange application, check out these helpful resources:

- Our Superbolt CAD Download Service enables easy access to mechanical tensioner CAD files and is compatible with a variety of CAD software programs
- The Boltplus Bolt Load Calculator recommends hydraulic bolt tensioners that are right for your standard flange applications
- Our Boltight Rental Service provides rental fleets to maintenance companies for when they need them — contact bolting@nord-lock.com



MIDSTREAM APPLICATION: AIR COMPRESSOR INSTALLATION

Used in thousands of applications for exploration, transportation, processing and refining, and distribution, industrial air compressors are vital to the oil and gas industry.

With some compressors, installation and removal of their connecting rod nuts can be difficult because of high torque requirements. What's more, traditional torqueing methods of using snipes and hammer wrenching can be time-consuming, unsafe, and lead to inaccurate preload.

In a split-case ethane compressor job, two mechanics using only handheld torque wrenches and impacts were able to safely replace its hydraulically tensioned bolting in just three hours. They installed 18 size M56 Superbolt multi-jackbolt tensioners (MJTs) on top of the case, plus a pair each of size M56 and M48 Superbolt MJTs on the bottom. Additionally, the Superbolt MJTs required only 131 Nm of torque compared to 10,000 Nm equivalent hex nut torque.

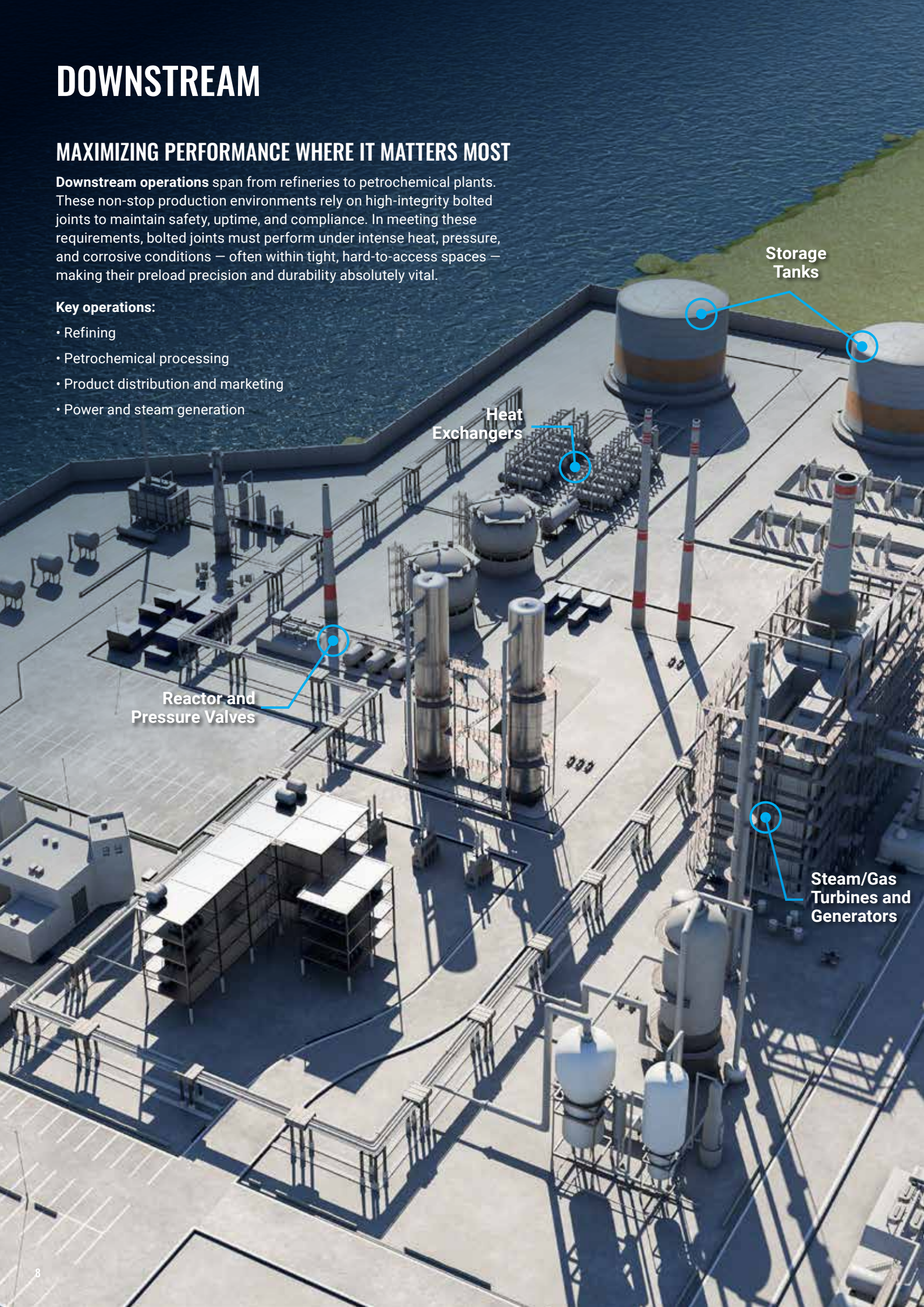
DOWNSTREAM

MAXIMIZING PERFORMANCE WHERE IT MATTERS MOST

Downstream operations span from refineries to petrochemical plants. These non-stop production environments rely on high-integrity bolted joints to maintain safety, uptime, and compliance. In meeting these requirements, bolted joints must perform under intense heat, pressure, and corrosive conditions — often within tight, hard-to-access spaces — making their preload precision and durability absolutely vital.

Key operations:

- Refining
- Petrochemical processing
- Product distribution and marketing
- Power and steam generation



COMMON CHALLENGES IN DOWNSTREAM

Refineries, gas terminals, and petrochemical plants employed in downstream operations must adhere to strict safety and operational standards. The reliability of critical components in these complex facilities is essential, and regular maintenance and upgrades are imperative to ensure safe, efficient, and continuous operation.

- Thermal cycling and pressure fluctuations
- Space-restricted environments for tooling
- Safety risks during turnarounds and shutdowns
- Corrosive exposure and bolt preload loss over time

Superbolt® mechanical tensioning solutions

- **EzFit Expansion Bolts** are radially expanding, axially tensioned coupling bolts that replace traditional fitted bolts. EzFit ensures quick and easy installation and removal, making them ideal for rotating coupling applications such as steam turbines, gas turbines, and propulsion systems.
- **The Superbolt Tool** significantly reduces installation and removal time, making it the preferred solution for users with many MJTs or frequent maintenance schedules. Alternatively, the **Single Jackbolt Tool** bridges the cost-performance gap, enhancing efficiency and portability in the field.

Boltight® hydraulic tensioning solutions

- **TSR+ Tensioners** are the fastest auto-return tensioners on the market, providing quick, safe, and reliable operation for oil and gas flanges, pressure vessels, and heat exchanger applications.
- **Echometer Premier** is a compact and portable ultrasonic tool that measures bolt load, stress, and elongation accurately, allowing fast, non-intrusive preload verification and ensuring reliable joint integrity.
- **Hydraulic Nuts** use an internal hydraulic jack to quickly and accurately tension large bolts, ensuring even load distribution and long-term reliability for manway covers and pressure vessels.

REDUCE DOWNTIME

Learn more about Nord-Lock Group's reliable and resilient bolting solutions by visiting and exploring our virtual downstream environment. And find out how to solve common leakage issues associated with heat exchanger flange bolting in a highly informative white paper written by Superbolt Senior Product Specialist Stephen J. Busalacchi.

DOWNSTREAM APPLICATION: LEAK ELIMINATION

Even a minor leak in petrochemical plants can compromise safety, harm environmental integrity, reduce operational efficiency, and drive up maintenance and downtime costs. Preventing such leaks demands accurate control of bolt preload, ensuring that every joint can withstand high-pressure and high-temperature operating conditions.

As a practical example, Boltight provided a customized hydraulic tensioning package that effectively eliminated recurring leaks in critical high-pressure gasket joints at a major petrochemical complex in South Korea.

The solution included:

- Custom M36 and M52 hydraulic tensioners for accurate and consistent preload application
- Echometer ultrasonic tools for swift, accurate measurement of bolt load
- On-site training and supervision to ensure correct use and long-term reliability

Through advanced technology and dedicated technical support, Boltight hydraulic tensioning solutions continue to help downstream operators maintain leak-free and reliable performance in demanding process environments.

UPSTREAM CASE STUDY: OFFSHORE PLATFORM LEG CONNECTIONS

Delivering reliable tensioning performance in corrosive offshore environments

CHALLENGE

An offshore gas platform in the Dutch sector of the North Sea — 133 meters high and weighing 8,800 tons — required secure leg connections able to withstand extreme wave forces and severe corrosion. The installation had to be completed without a crane vessel or heavy piling equipment, while allowing for future dismantling and relocation.

SOLUTION

Each of the platform's four legs was fastened with four Superbolt multi-jackbolt tensioners (5.5 m in length, 240 mm in diameter, and weighing over 2,000 kilograms). Designed to provide a preload of 12,000 kN, the tensioners featured a specially sealed design to ensure long-term corrosion protection and maintain preload under high dynamic loads and vibration.

This solution enabled safe and precise installation, with the full leg assembly completed in just two days and four hours, ensuring operational reliability and structural integrity in a demanding offshore environment.

MIDSTREAM CASE STUDY: SUBSEA PIPELINE CONNECTIONS

Ensuring accurate and reliable tensioning in deepwater conditions

CHALLENGE

A 325-kilometer offshore gas pipeline was being constructed across the Nam Con Son and Cuu Long basins in Vietnam to transport 20 million standard cubic meters of gas per day. The project required a subsea tensioning solution capable of withstanding high external pressure and temperature variations, ensuring accurate and even preload across all flange connections in deepwater conditions.

SOLUTION

Boltight hydraulic subsea tensioners, ranging from M33 to M52, were supplied to enable simultaneous tightening of all bolts using a staggered bolting arrangement. This method ensured each bolt was tensioned to the same pressure and preload, achieving uniform load distribution across the connections. A complete 1,500-bar tensioning system — including pumps, link hoses, and 30-meter downline hoses and reels for subsea use — was also provided. The solution delivered accurate and reliable tensioning, securing all critical joints and maintaining pipeline integrity under harsh subsea conditions.

DOWNSTREAM CASE STUDY: HEAT EXCHANGER HEAD CONNECTIONS

Achieving leak-free performance and faster maintenance turnaround

CHALLENGE

At a Repsol refinery in Malaysia, recurring leaks occurred in heat exchanger heads sealed with conventional hex nuts tightened by hydraulic torque wrenches. The method caused inconsistent preload and time-consuming disassembly during maintenance. The client required a solution that could deliver accurate, repeatable tensioning and ensure leak-free operation under medium-temperature, corrosive conditions.

SOLUTION

Custom-made Superbolt H650 multi-jackbolt tensioners with Xylan® coating were installed on one of two identical heat exchangers, replacing the original hex nuts. The new design enabled precise pretensioning without hydraulic tools, offering faster, safer, and more consistent tightening. Downtime for head removal dropped from 17 man-hours to just four, providing substantial labor and cost savings. After hydrostatic testing, the Superbolt-equipped unit achieved zero leaks and consistent stud preload, confirming long-term reliability in demanding refinery service.

IMPROVE CRITICAL OPERATIONS ACROSS ALL STREAMS

Energy operations require bolting technologies engineered to perform under extreme pressure, temperature, vibration, and corrosion. At the same time, these solutions must deliver adaptability and versatility — enabling safe and efficient use in confined spaces, pipeline systems, and offshore structures.

Nord-Lock Group addresses these challenges through advanced materials science, protective coating technologies, and comprehensive finite element and joint analysis. These capabilities validate the integrity of both standard and custom-engineered Superbolt® and Boltight® tensioning solutions, ensuring reliable performance across all stages of oil and gas operations. Our technologies offer:

- **Safety and Risk Reduction:** Fail-safe designs prevent leaks, minimize explosion risks, and ensure compliance with HSE regulations. Protecting people and assets remains our top priority.
- **Structural Integrity and Reliability:** Proven performance, backed by decades of field experience, ensures the long-term stability of critical joints and equipment.
- **Time and Cost Efficiency:** Superbolt and Boltight tensioners enable faster installation and maintenance, significantly reducing downtime and optimizing OPEX.
- **Sustainable Operations:** Innovations enable responsible operations — reducing carbon emissions, improving efficiency, and extending equipment life cycles.
- **Compliance and Certification:** Fully aligned with API, ASME, and ISO standards, and engineered to meet operator and EPC specifications.

As the only provider of both mechanical and hydraulic tensioning technologies, Nord-Lock Group ensures safety, efficiency, and adaptability across every stage of oil and gas operations. With proven experience and a commitment to innovation, we enable energy companies to protect and optimize their most critical assets.

Choose Nord-Lock Group as your trusted partner for upstream, midstream, and downstream operations.

ENGINEERED TO PERFORM UNDER EXTREME CONDITIONS

Nord-Lock Group is a global leader in bolted solutions. In 1982, the original Nord-Lock® wedge-locking technology that safely secures bolted joints was developed. Since then, our range of innovative bolting technologies and expertise has grown to be the most comprehensive on the market, incorporating Superbolt® mechanical tensioners, Boltight® hydraulic tensioners, and Expander System® pivot pins. All solutions are developed and manufactured in-house, ensuring they meet the highest standards in the industry. Our team of dedicated experts works closely with customers all over the world.

Nord-Lock Group is an ISO:9001 manufacturer.

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